marconi instruments

TF 2337A

AUTOMATIC DISTORTION METER

Instruction Manual

NOTES AND CAUTIONS

ELECTRICAL SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

Fuses

Note that the supply fuse is connected in series with the brown (live) wire of the supply lead. If the equipment is connected to the supply via a two-pin plug, it will be possible for the fuse to become connected to the neutral side depending upon the orientation of the plug in its socket. In these circumstances certain parts of the instrument could remain at supply potential even after the fuse has ruptured.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

RADIO FREQUENCY INTERFERENCE

This equipment conforms with the requirements of EEC Directive 76/889 as to limits of r.f. interference.

S/N M-100825
1/13/82 NEW.

Instruction Manual

No. EB 2337A

for

Automatic Distortion Meter TF 2337A

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

M.I. 0.2c
6/76 JPR

EB 2337A
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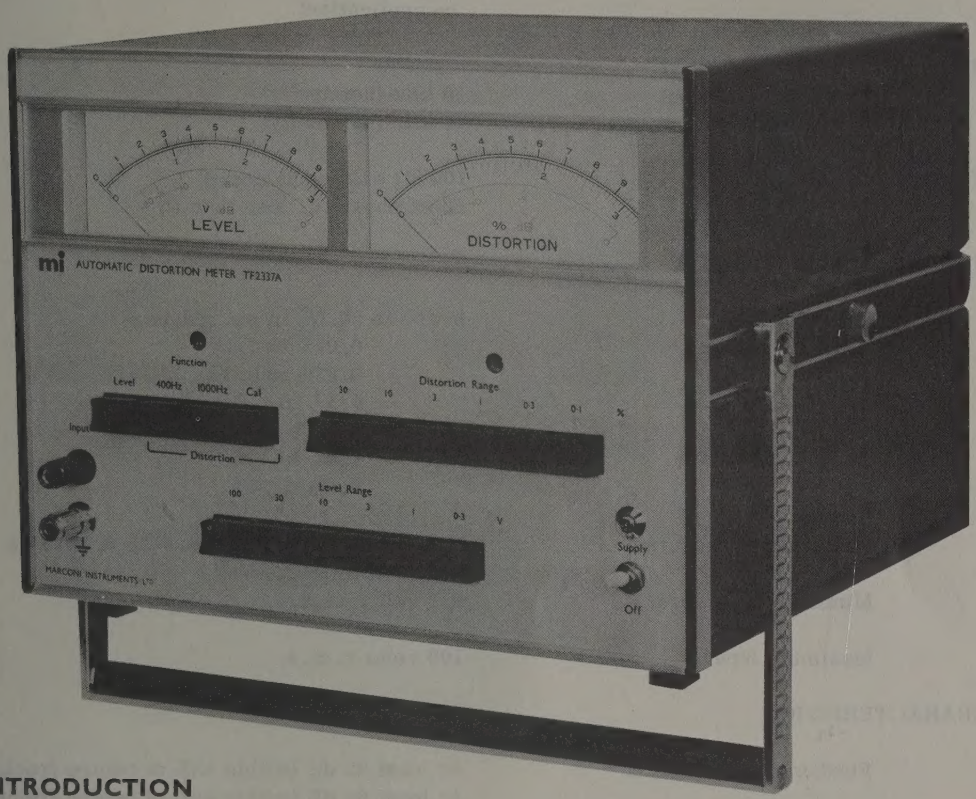
Chapter 1

General information



1.1 INTRODUCTION

The TF 2337A Automatic Distortion Meter enables rapid and accurate measurement of both level and distortion factors of audio frequency signals. The need to tune for fundamental frequency rejection is avoided, thus operation simply consists of the selection by push button switches of the input voltage range, distortion range and fundamental frequency.

The instrument measures distortion in the conventional way, that is, by filtering out the fundamental component and comparing the residual with that of the total signal. However, because of the novel design of the ratio circuit the need for reference level adjustment prior to distortion measurement is obviated. Thus fluctuations of the input level (up to -10 dB) will not affect the accuracy of the distortion measurement.

The TF 2337A is therefore suitable for repetitive distortion measurements and because of its simplicity of operation is ideal for factory testing of mass production units such as a.f. amplifiers etc. Furthermore as the instrument employs a multi-stage Twin-T active filter having a fairly wide rejection band (66 dB at +5% of f_0), the affect of wow and flutter on the distortion measurement is negligible. This attribute is particularly useful for t.h.d. measurements of output signals on equipment such as tape recorders and record players.

Owing to the use of field effect transistors in the input stage, internal noise is low and therefore with input signals as low as 10 mV, distortion can be measured down to 0.01%.

1.2 DATA SUMMARY

FUNDAMENTAL FREQUENCIES	400 Hz ±5% 1000 Hz ±5% (optional frequencies available on application)
BANDWIDTH (Upper -3 dB point)	
Level measurement	20 kHz (nominally)
Distortion measurement	10 kHz (nominally)
INPUT IMPEDANCE	100 kΩ ±10% unbalanced Shunt capacity, less than 50 pF
DISTORTION MEASUREMENT	
Range	0.01% to 30.0% in six ranges - 0.01% to 0.1% 0.03% to 0.3% 0.1% to 1.0% 0.3% to 3.0% 1.0% to 10% 3.0% to 30%
Measurement accuracy	±3% f.s.d. of each range, ±2% of reading.
Minimum input level	0.1 volt r.m.s.
Maximum input	100 volts r.m.s.
FILTER CHARACTERISTICS	
Fundamental rejection	At least 83 dB (within ±3% of centre frequency). At least 66 dB (within ±5% of centre frequency).
Harmonic frequency response for -	
400 Hz filter	760 Hz to 10 kHz within 0.6 dB.
1000 Hz filter	1900 Hz to 10 kHz within 0.6 dB.
LEVEL MEASUREMENT	
Range	0.03 to 100 volts r.m.s. in six ranges - 0.03 to 0.3 volts r.m.s. 0.1 to 1.0 volts r.m.s. 0.3 to 3.0 volts r.m.s. 1.0 to 10 volts r.m.s. 3.0 to 30 volts r.m.s. 10 to 100 volts r.m.s.
Accuracy	±3% f.s.d. of each range.
Frequency response	Flat to within 1 dB over the band 20 Hz to 20 kHz.
POWER REQUIREMENTS	95 to 125 volts or 190 to 250 volts 50 to 60 Hz 6 VA.

DIMENSIONS AND WEIGHT	Height	Width	Depth	Weight
	210 mm	285 mm	270 mm	6 kg
	8.2 in	11.2 in	10.6 in	12 lbs

Chapter 2

Operation

2.1 INSTALLATION

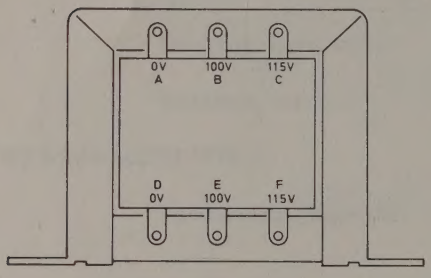
The TF 2337A Automatic Distortion meter is available only for bench mounting. Normally set on four rubber feet, the instrument can be used in the tilted position by swinging the carrying handle forward and downwards until it is positively located in the vertical position. The handle then acts as a tilt stand.

2.2 POWER SUPPLY

The instrument is normally supplied ready for use with 230 V a.c. mains supply. Before connecting to the mains supply ensure that the mains voltage setting is correct and the correct mains fuse is fitted as follows :-

Mains supply	Fuse rating	MI Part No.
95-125 V a.c.	0.2 amps	FPP/2337A/23401
190-250 V a.c.	0.1 amp	FPP/2337A/23402

2.2.1 Mains Transformer Tapping



VOLTAGE RANGE	SHORTING	TAPPING
90 ~ 110V	A-D, B-E	A, B
104 ~ 130V	A-D, C-F	A, C
180 ~ 220	B-D	A, E
207 ~ 253	C-D	A, F

Fig. 2.1 Mains transformer tappings

To adjust mains voltage setting proceed as follows :

(i) Remove the top cover of the instrument by releasing the two knurled knobs located on each side of the instrument.

(ii) Locate the mains transformer situated in the top right hand corner.

(iii) Check that thetapping is as illustrated in Fig. 2.1 for 230 V a.c.

(iv) If an alternative setting is required, adjust the transformer tappings as indicated in the adjacent table.

NOTE : An orange wire from the indicator lamp (PL1) on the front panel is connected to the mains transformer terminal (B). This lead should not be moved as it also supplies the 100 V working voltage for the neon lamp.

2.3 CONTROLS AND CONNECTIONS

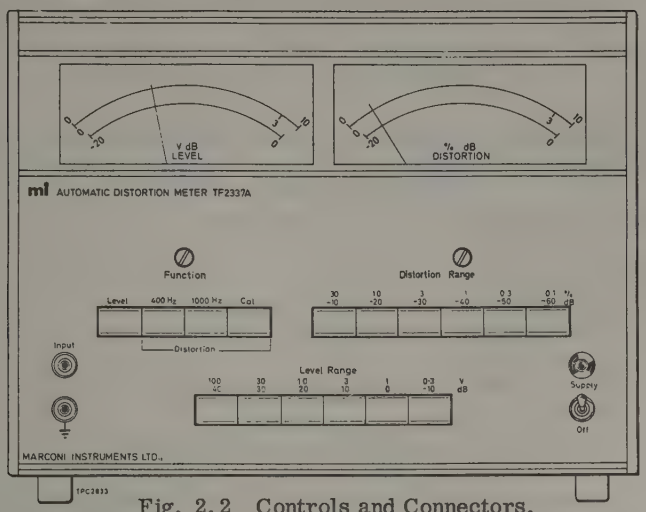


Fig. 2.2 Controls and Connectors.

(1) ON/OFF SUPPLY switch. The indicator lamp will illuminate when the supply is switched on.

(2) INPUT terminals. Two terminals, one insulated for signal connection. Connection can be made by banana plugs or spade terminals.

(3) FUNCTION switch (S2). Four position push-button switch. The Level position ensures only level measurements are made whereas with the 400 Hz or 1000 Hz push button selected the instrument will measure both level and distortion factor.

With the CAL push button selected a pre-determined signal is fed to the distortion measuring circuit as a distortion calibration check.

(4) LEVEL RANGE switch (S1). Consisting of six push buttons, selection of which will determine the full-scale range of the level meter. Each button is calibrated in volts and dB's.

(5) LEVEL meter. Consists of three scales, two voltage scales in black and a dB scale in red (0 dB = 1 V).

(6) DISTORTION RANGE switch (S3). Consisting of six push buttons, selection of which will determine the full-scale range of the distortion meter. Each push button is calibrated in full-scale distortion percentage and dB's.

(7) DISTORTION meter. Consists of three scales, two distortion factor range scales in black and one distortion scale (dB) in red. (0 dB = 100% distortion factor).

2.4 OPERATION

The following instructions are intended as a detailed guide to the operation of the TF 2337A Automatic Distortion Meter. However, because of the units inherent simplicity, continued use of these instructions will become unnecessary.

2.4.1 Preparation for use

Before commencing measurement,

(i) ensure that the mains transformer tapping and fuse rating are correct for the supply in use.

(ii) ensure that the mechanical zero of both meters is correctly set. Adjustment is made using the inset screw located centrally below each meter.

(iii) ensure that all push buttons are in the 'out' position and that the supply switch is in the off position.

(iv) connect the instrument to the supply and switch on. Check that the supply indicating lamp is illuminated.

The TF 2337A is now ready for use, proceed as follows :

2.4.2 Level Measurement

(i) Select the LEVEL push button of the FUNCTION switch.

(ii) Select the 100 V (40 dB) push button of the LEVEL RANGE switch.

(iii) Connect the signal to be measured to the input terminals.

(iv) Observe the reading on the LEVEL meter. If the reading is not within the 0 dB to -10 dB scale, continue to select successively lower LEVEL ranges until the desired indication is obtained.

(v) Note the LEVEL push button selected. The full-scale of the meter is determined by and indicated above this push button.

If measurement is required in dB's the signal level is determined by the sum of the meter indication and the dB value indicated (in RED) above the selected push button e.g. with the 30 dB (30 V) push button depressed and the meter reading -5 dB, the signal level will be 25 dB above 1 V.

2.4.3 Distortion Measurement

(i) Carry out Level measurement as described in Chapter 2.4.3 (i) to (iv).

(ii) Select the desired fundamental filter by selecting either the 400 Hz or 1000 Hz push button.

(iii) Select the 30% (-10 dB) push button of the DISTORTION RANGE switch.

(iv) Observe the reading on the distortion meter. If the indication is towards the -20 dB end of the scale select lower distortion ranges until the indication can be easily read.

The meter full-scale range is indicated by the percentage figure (black) above the press button selected.

If measurement is required in dB's, the distortion level is determined by adding the meter dB indication (red) to the dB figure (red) immediately above the selected push button.

i.e. if the -40 dB push button of the Distortion Range Switch is selected and the meter indicates -3 dB then the distortion level measured is -43 dB (0.7%).

NOTE : The distortion measurement is valid only if the level meter indication lies between -10 and 0 on the dB scale.

2.5 CALIBRATION

A facility for checking the distortion measuring circuits is provided. Proceed as follows :-

(i) Check that the level meter indication lies between 0 dB and -10 dB as previously described.

(ii) Select the CAL push button of the function switch.

(iii) The distortion meter indication should read 10 (f.s.d. on the upper range) regardless of the distortion range selected. If the indication is in error by more than one division, refer to Chapter 5.2 for re-alignment instructions.

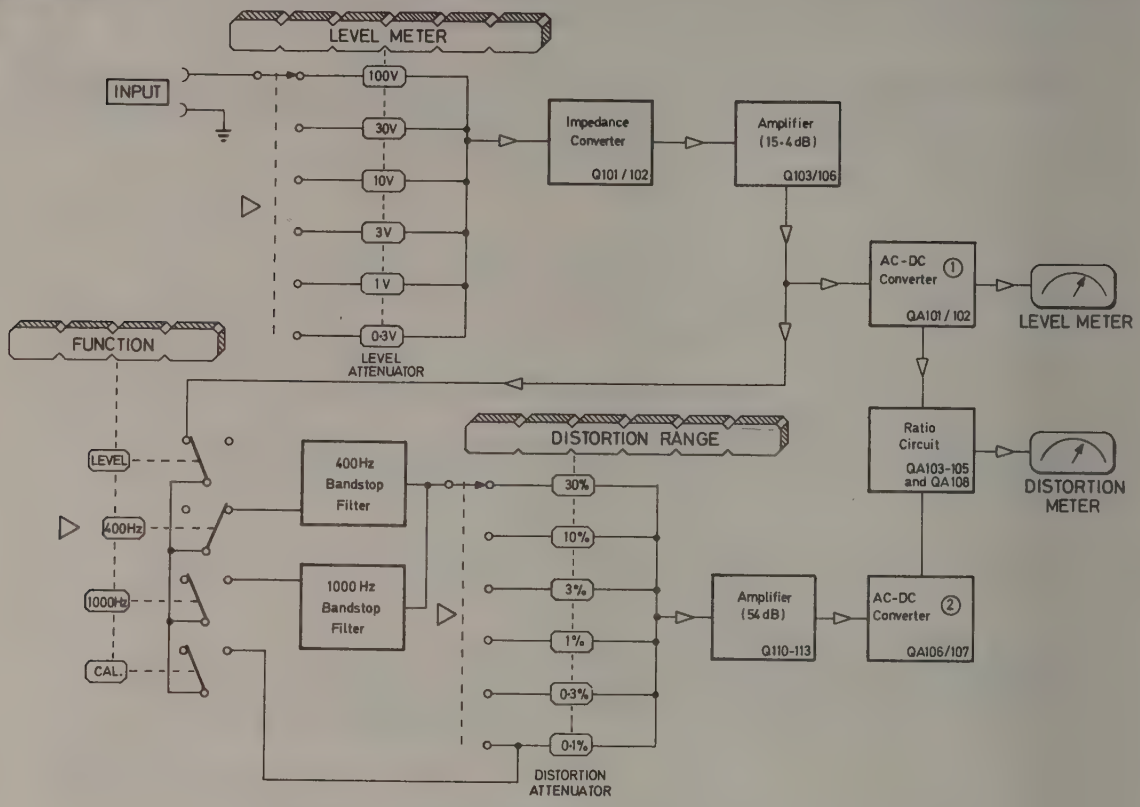


Fig. 3.1 Block Diagram TF 2337A

3.1 PRINCIPLES OF OPERATION

The method of distortion measurement is carried out in the usual way by filtering out the fundamental component and comparing the amplitude of the residual with that of the total signal.

Distortion analysis - Distortion factor is defined by the equation -

$$\text{DISTORTION FACTOR} = \sqrt{\frac{V_2^2 + V_3^2 + \ldots V_n^2 + N^2}{V_1}} \times 100\%$$

where V_1 = amplitude of fundamental

$V_2, V_3 \ldots V_n$ = amplitude of 2nd, 3rd .... nth harmonic

N = amplitude of noise and hum harmonics.

The method employed by the TF 2337A Automatic Distortion Meter is based on the following approximation which, assuming a distortion factor of less than 15%, introduces no appreciable error -

$$\text{DISTORTION FACTOR} = \sqrt{\frac{V_2^2 + V_3^2 + \ldots V_n^2 + N^2}{V_1^2 + V_2^2 + V_3^2 + \ldots V_n^2 + N^2}} \times 100\%$$

3.2 GENERAL SUMMARY

The signal to be measured is first fed to the LEVEL measuring circuits to determine the correct input conditions for the DISTORTION measurement and to provide a LEVEL measurement facility.

The signal is fed via LEVEL input attenuator (S1) to impedance converter and 15.4 dB amplifier and thence to LEVEL AC/DC converter to provide a +5.25 voltage for full-scale deflection of the LEVEL meter.

With the distortion measurement mode selected the signal from the LEVEL amplifier is simultaneously fed via FUNCTION select switch (S2) to one of the two internal filters. The signal stripped of its fundamental frequency, is attenuated and fed via the AC/DC converter to the 'ratio' circuit together with the signal from the LEVEL AC/DC converter. Thus both signals can be compared by the 'ratio' circuit (as described in Section 3.3.1 and defined in Section 3.1) and their ratio indicated directly by the DISTORTION meter (M2).

3.3 CIRCUIT DESCRIPTION

LEVEL RANGE ATTENUATOR (S1). Front panel mounted 6-way push button switch consisting of one 'straight through' position and five 10 dB steps.

LEVEL IMPEDANCE CONVERTER (Q101,102). Large gain amplifier with 100% negative feedback provides high input and low output impedance with a wide band frequency response. Although distortion is low, any distortion induced by the amplifier is minimized by adjustment of the bias voltage to Q101.

LEVEL AMPLIFIER (Q103 to Q106). To minimize induced distortion this amplifier has high open loop gain and low closed loop gain. The gain is adjusted for 15.4 dB by R119 (LEVEL GAIN).

The output of this stage is also fed to the FUNCTION switch S2.

LEVEL AC/DC CONVERTER (QA101/QA102) uses diode full-wave rectification. To reduce the effects of the non-linearity of the rectifying circuit a negative feedback system also using diodes is incorporated.

The d.c. output to M1 (LEVEL METER) is determined by the setting of R134 and R119 of the previous stage. The d.c. output required for a full-scale deflection of M1 is +5.25 volts.

FUNCTION switch (S2) consists of four push buttons.

With the LEVEL push button selected the output from the LEVEL amplifier to the distortion measuring circuits is open circuited. It should be noted that although the distortion circuits are switched out with the selection of the LEVEL push button, the level measuring circuits are always operative.

Selecting either of the 400 Hz or 1000 Hz push buttons, applies the total signal (suitably attenuated by the LEVEL input attenuator) to the appropriate filter.

The CAL push button when operated applies the output from the LEVEL amp, attenuated by the full 60 dB of the DISTORTION range switch (S3), directly to the DISTORTION amplifier. The levels are set such that when the LEVEL meter reads full-scale the DISTORTION meter also reads full-scale. The check is completed by reducing the input signal level by 10 dB and checking that the distortion meter reading varies by no more than 1%.

FUNDAMENTAL REJECTION FILTERS are composed of active twin-T four stage elements having a notch characteristic as shown in Fig. 3.2. Two filters are fitted having fundamental rejection of 400 Hz and 1000 Hz.

DISTORTION RANGE ATTENUATOR (S3) Front Panel mounted 6-way push button switch consisting of one 'straight through' position and five 10 dB steps.

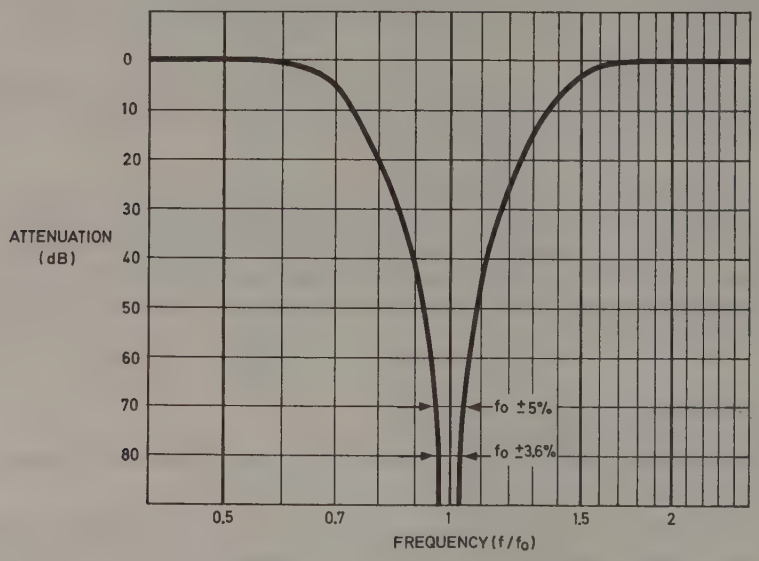


Fig. 3.2 Fundamental rejection characteristics of TF 2337A Filter.

DISTORTION AMPLIFIER (Q110 to Q113) 54 dB gain adjusted in the feedback circuit by R159 (DIST GAIN).

DISTORTION AC/DC CONVERTER (QA106/QA107) similar circuit to the level a.c./d.c. converter but differs in gain and output polarity.

RATIO CIRCUIT comprises an up-down integrator and pulse width to d.c. converter as shown in simplified form Fig. 3.3.

3.3.1 Detailed description of Ratio Circuit

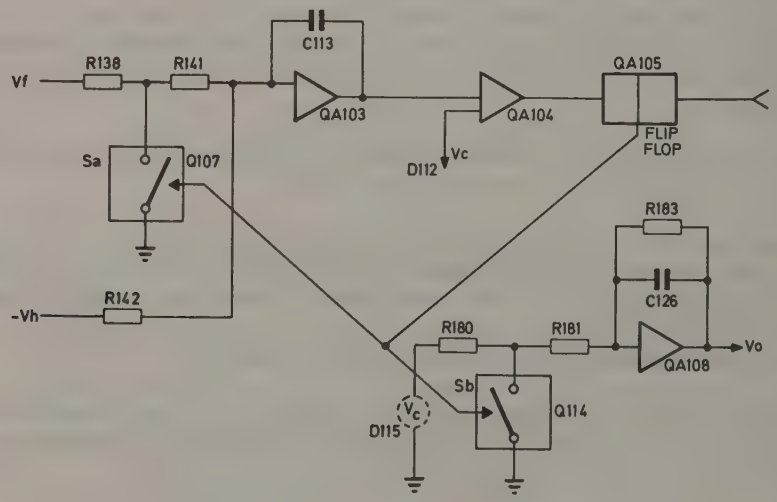


Fig. 3.3 Simplified diagram of ratio circuit.

The two signals applied to the ratio circuit are Vf derived from the Level AC/DC converter and -Vh from the Distortion AC/DC converter.

Switches Sa (Q107) and Sb (Q114) are reset in the open condition at time interval T (see Fig. 3.4) by a clock triggered flip-flop QA105. Thus with Sa open the signals Vf and -Vh combine to charge capacitor C113. When the output of QA103 reaches Vc, comparator QA104 actuates flip-flop QA105 to close Sa leaving signal -Vh to charge C113 in the reverse direction for time T -Tx (Fig. 3.4).

The flip-flop change over time Tx is therefore dependent on the relative values of Vf and -Vh.

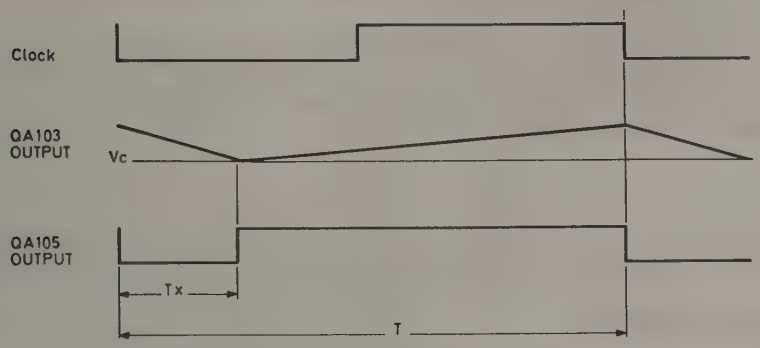


Fig. 3.4 Timing sequence of ratio circuit

The switching action of Sa is repeated by Sb (Q114) producing a pulse, the period of which is identical to T -Tx, integrated by Circuit QA108/C126/R183 and thus deriving an output voltage Vo directly proportional to the ratio of the harmonic content of the signal and its total value (Vh/Vf). Distortion meter (M2) indicates the value Vo.

Chapter 4

Maintenance

4.1 INTRODUCTION

This chapter contains information on performance checks and calibration procedures.

Performance limits quoted are for guidance only and should not be taken as guaranteed performance specification unless they are also quoted in the Data Summary (Chapter 1.2).

In case of difficulties that cannot be resolved with the aid of this manual, please contact our Service Division at the address stated on the back cover, or your nearest Marconi Instruments representative quoting the type and serial number of the instrument. If the instrument is being returned for repair, please indicate clearly the nature of the fault or the work you require to be done.

4.2 ACCESS

Access to the instrument can be achieved by rotating the two knurled knobs on the side of the instrument in the direction indicated adjacent to the knobs which will release the top and bottom panels.

4.3 PERFORMANCE CHECKS

The tests in this section may be used as a routine maintenance procedure to verify the main performance parameters of the instrument. All tests can be completed without removing the case. If adjustment becomes necessary the appropriate procedures are detailed in the repair section Chapter 5.

Equipment required :-

Instrument	Required specification
Voltage calibrator	AC voltage range : 100 mV to 100 V r.m.s. e.g., Bradley 125C
Low distortion oscillator	Frequency range : 20 Hz to 20 kHz. Distortion $<0.01\%$ e.g. TF 2100/1 M1
AC voltmeter	Voltage range : 100 mV to 100 V r.m.s. Frequency range : 20 Hz to 20 kHz } e.g. TF 2671
DC voltmeter	Voltage range : 0 to ±2 volts
L-C meter	Capacitance range : 0 to 70 pF e.g. TF 1313A
Counter	Frequency range : 20 Hz to 20 kHz e.g. TF 2417
Switch box	See Fig. 4.3
Resistor	Resistance : 100 kΩ 1% fixed carbon film
Variable mains voltage transformer	Voltage range : 90 V to 127 V or 180 V to 253 V

4.3.1 Level Meter Accuracy

(a) Test equipment required : Voltage calibrator.

(b) Check that the instrument is correctly adjusted for the mains voltage in use as described in Chapter 2.4.1.

Set controls of the TF 2337A Automatic Distortion Meter as follows :

Function switch - LEVEL

(c) Connect the voltage calibrator to the input terminals of the TF 2337A.

(d) Set the output frequency from the voltage calibrator to 1000 Hz.

(e) By using the voltage calibrator check the level meter at f.s.d. on every LEVEL range.

The accuracy of level range should be within ±2%.

(f) Set the Level Range of the TF 2337A to 1 V.

(g) By using the voltage calibrator, check the scale shape of the level meter, varying the voltage by increments of 0.1 V from 0.1 V to 1 V.

The scale shape of the level meter should be within ±2% of full scale.

(h) Reduce the mains voltage by 10% and repeat steps (e) to (g). Increase the mains voltage to the nominal voltage plus 10% and repeat steps (e) to (g).

4.3.2 Level Meter Frequency Response

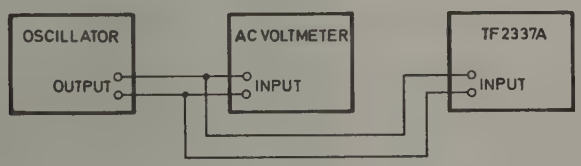


Fig. 4.1 Level Meter Frequency response check

(a) Test equipment required : Oscillator and AC voltmeter.

(b) Connect the TF 2337A as shown in Fig. 4.1.

(c) Set the TF 2377A controls as follows :-

Function switch - LEVEL

Level range switch - 1 V

(d) Set the oscillator frequency to 1000 Hz, adjust the output so that the TF 2337A Level Meter reads full scale. Note the oscillator output as monitored by the AC voltmeter.

(e) Keep the output from the oscillator constant and vary the frequency from 20 Hz to 20 kHz.

(f) Ensure that the frequency response of the level meter of the TF 2337A is within ±3% over the frequency range 20 Hz to 20 kHz.

4.3.3 Band Rejection Filter

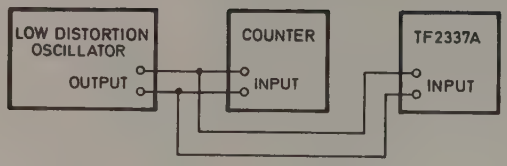


Fig. 4.2 Fundamental Rejection Filter check

(a) Test equipment required :

Low distortion oscillator

Counter

(b) Connect the TF 2337A as shown in Fig. 4.2.

(c) Set TF 2337A controls as follows :-

Function switch	-	LEVEL
Level range switch	-	1 V

(d) Connect the output of the low distortion oscillator to the input of the TF 2337A.

(e) Set the frequency of the low distortion oscillator to 400 Hz and, varying the output, set the level meter of the TF 2337A to full scale.

(f) Set the switches of the TF 2337A as follows :

Function switch	-	400 Hz
Distortion range switch	-	0.1%

(g) Vary the frequency of the low distortion meter so that the distortion meter of the TF 2337A indicates 0.007%. Check the frequency at two points (+ and -) of the fundamental frequency to confirm that the frequency width is more than ±3%.

(h) Check that the centre frequency of the two points noted above is within ±1% of 400 Hz.

i) Select the TF 2337A controls as follows : -

Function switch	-	1,000 Hz.

j) Set the output frequency of the low distortion oscillator to 1000 Hz and, varying the output, set the level meter of the TF 2337A to full scale.

k) Select the TF 2337A controls as follows :-

Function switch	-	1000 Hz
Distortion range switch	-	0.1%

l) Carry out the operation described in para. 4.3.3(g).

Check that the centre frequency of the two points corresponding to 0.007% distortion is within ±1% of 1000 Hz.

4.3.4 Harmonic Characteristic

a) Test equipment required :

Oscillator

AC voltmeter

b) Connect the TF 2337A as shown in Fig. 4.1.

c) Select the TF 2337A controls as follows : -

Function switch - LEVEL

Level range switch - 1 V

d) Adjust the output frequency of the oscillator to 760 Hz and adjust the output until the TF 2337A level meter reads full-scale.

e) Select the TF 2337A controls as follows :-

Function switch - Press the CAL and 400 Hz push-buttons simultaneously.

f) Note the indication of distortion of the TF 2337A, vary the frequency of the oscillator from 760 Hz to 10 kHz.
(The output voltage from the oscillator should be kept constant.)

Ensure that the distortion meter of the TF 2337A does not vary more than ±0.3 dB.

g) Select the TF 2337A controls as follows :

Function switch - LEVEL

h) Set the frequency of the oscillator to 1.9 kHz, and set the indication of level meter of the TF 2337A to full scale.

i) Select the following mode condition :

Function switch - Press the CAL and 1000 Hz push-buttons simultaneously.

j) Noting the distortion reading on the TF 2337A, vary the frequency of the oscillator from 1.9 kHz to 10 kHz.
(The output from the oscillator should be kept constant.)

k) Confirm that the TF 2337A distortion indication is constant within ±0.3 dB.

4.3.5 Distortion Meter Accuracy

a) Test equipment required.

Low distortion oscillator.

Voltage calibrator.

Switch box.

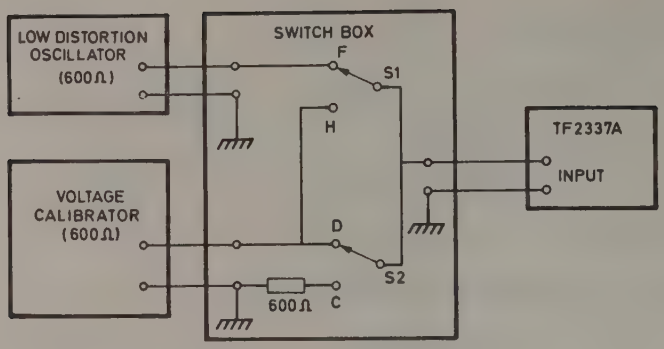


Fig. 4.3 Distortion Meter accuracy check

b) Connect the TF 2337A and test equipment as shown in Fig. 4.3.

c) Set the controls of the TF 2337A as follows :-

Function switch - LEVEL

Level range switch - 1 V

d) Turn S1 of the switch box to F and S2 of the switch box to C.

e) Set the frequency of the low distortion oscillator to 400 Hz and varying the output, set the level meter of the TF 2337A to full scale (1 V).

f) Turn S1 of the switch box to H.

g) Set the frequency of the voltage calibrator to 880 Hz and varying the output, adjust the TF 2337A level indication to full scale (1 V).

h) Set the output from the voltage calibrator to 0.001 V.

i) Turn S1 of the switch box to F and the S2 to D.

j) Set controls of the TF 2337A as follows :-

Function switch - 400 Hz

Distortion range switch - 0.1%

k) Check that the TF 2337A distortion meter reads f. s. d.

l) Select the TF 2337A distortion range and adjust the voltage calibrator as tabled below checking that the TF 2337A meter indicates full scale.

TF 2337A distortion range	-	0.3%	1%	3%	10%	30%
Voltage calibrator	-	0.003 V	0.01 V	0.03 V	0.1 V	0.3 V

m) Set the distortion range of the TF 2337A to 1% and set the voltage calibration to 0.01 V.

n) Vary the output from the voltage calibrator from 0.001 V to 0.01 V in steps of 0.001 V and check the accuracy of the distortion meter.

o) The accuracy of the distortion meter should be ±3% of reading ±3% f. s. d.

p) Select the 1000 Hz push-button on the Function switch.

q) Set the frequency of the low distortion oscillator to 1000 Hz and that of the voltage calibrator to 2,200 Hz. Carry out checks of items (c) to (n).

4.3.6 Ratio Circuit

a) Test equipment required :

Low distortion oscillator

Voltage calibrator

Switch box

b) Connect the TF 2337A as shown in Fig. 4.3.

c) Carry out the operations (c) to (k) described in distortion meter accuracy check, para. 4.3.5.

d) Vary the LEVEL RANGE from 1 V to 3 V, ensure that the indication of distortion does not vary by more than ±1% of f. s. d.

e) Select the 1 V push-button on the Level Range.

f) Set the output from the voltage calibrator to 0.003 V.

g) Vary the LEVEL RANGE from 1 V to 3 V, ensuring that the indication of distortion does not vary by more than ±1% of f. s. d.

h) Select the 1 V push-button on the Level Range.

i) Set the output from the voltage calibrator to 0.001 V.

j) Vary the LEVEL RANGE from 1 V to 3 V, ensure that the indication of distortion does not vary by more than ±1% of f. s. d.

4.3.7 Input Resistance

a) Test equipment required :

Oscillator

Resistor 100 kΩ ±1%

b) Connect the output of the oscillator to the input terminals of the TF 2337A.

c) Set the controls of the TF 2337A as follows :-

Function switch - LEVEL

Level range switch - 1 V

d) Set the output frequency of the oscillator to 1 kHz.

e) Vary the output voltage of the oscillator so that the level meter of the TF 2337A reads full scale. Note this reading (E in the equation).

f) Connect a 100 kΩ ±1% resistor in a series with the input to the TF 2337A. Note the LEVEL METER reading (V in the equation).

g) Input resistance (R input) of the TF 2337A is given as follows :

$$R \text{ input} = \frac{Vo}{E - V} \times 100 \text{ k}\Omega$$

h) The input resistance of the TF 2337A should be 100 kΩ ±5%.

4.3.8 Input Shunt Capacitance

a) Test equipment required

L - C meter

b) Set the controls of the TF 2337A as follows :-

Level range switch - 0.3 V

c) Connect the L - C meter to the input terminals of the TF 2337A. Measure the input capacitance which should be less than 70 pF.

Chapter 5

Repair

5.1 INTRODUCTION

This chapter contains information for the locating and repair of faults. Allignment procedures are also given. Performance limits quoted are for guidance only and should not be taken as guaranteed performance specifications unless they are also quoted in the Data summary section.

See also Chapter 4 for information on access.

In the case of any difficulty, please write to or 'phone the Marconi Instruments Service Division (see address on back cover) or nearest representative, quoting the type and serial number on the data plate at the rear of the instrument. If the instrument is being returned for repair, please indicate clearly the nature of the fault or the work you require to be done.

5.2 FAULT LOCATION

A list of fault symptoms that may be evident from the front panel checks or become apparent following internal adjustments, are listed in Table 5.1. Probable causes are indicated which will be useful in locating the fault.

The d.c. voltages of the active devices are listed in Tables 5.2(a) and (b).

Following the rectification of a fault, the relevant performance checks of Chapter 4 should be carried out to ensure that the TF 2337A is still within calibration.

5.3 TYPICAL WAVEFORMS

The waveforms given in Fig. 5.1 are representative of the TF 2337A when a signal of 1 kHz, 1 V r.m.s. is applied to the input terminals and the controls are set as follows :-

Function switch	-	CAL
Level range switch	-	1 V
Distortion range switch	-	Any

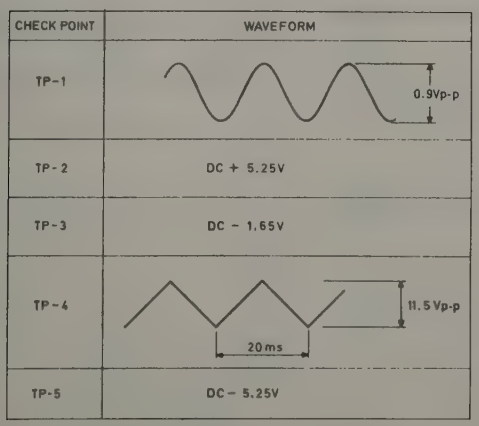


Fig. 5.1 Typical Waveforms

SYMPTOM	PRCBABLE CAUSE
Neon lamp does not light	Check the fuse
Level meter and distortion meter does not work when a signal is applied. (All ranges)	Check Q101 to Q106
Level meter does not work	Check QA101, QA102 and M1
Distortion meter does not work	Check from Q107 to Q114, QA103 to QA108 and M2
Adjust R202 (GAIN ADJ) and R227 (2fo ADJ) but does not become normal	Check QA201 to QA205
Adjust R326 (12 V ADJ) but +12 V and -12 V do not become normal	Check Q301 to Q311
Adjust R105 (BIAS ADJ) but bias does not become normal	Check Q101, Q102 and D101 to D104
Adjust R119 (LEVEL GAIN) but does not become normal	Check Q103 to Q105
Adjust R134 (LEVEL ZERO ADJ) but zero does not become normal	Check QA101 and QA102
Adjust R159 (DIST. GAIN) but does not become normal	Check from Q110 and Q113
Adjust R176 (RATIO ADJ) but does not become normal	Check from Q110 and Q113
Adjust R176 (RATIO ADJ) but does not become normal	Check QA106 and QA107
Adjust R184 (DIST. ZERO ADJ) but does not become normal	Check QA108 and Q114

Table 5.1 Fault location

TRANSISTOR	E	B	C
Q101	(s) -5.5 V	(G) *	(G) 10.1 V
Q102	10.8 V	10.1 V	-5.5 V
Q103	-0.58 V	0	5.6 V
Q104	-0.58 V	-0.02 V	6.7 V
Q105	6.25 V	5.6 V	0.55 V
Q106	-0.07 V	0.55 V	12.0 V
Q107	0	0.62 V	0.01 V
Q108	0	-0.4 V	2.1 V
Q109	0	-0.4 V	2.1 V
Q110	-0.56 V	0	6.2 V
Q111	-0.56 V	0	6.6 V
Q112	7.24 V	6.6 V	-5.9 V
Q113	-6.6 V	-5.9 V	0.2 V
Q114	0	0.64 V	0.03 V
Q301	12.5 V	13.1 V	18.8 V
Q302	12.0 V	12.5 V	18.8 V
Q303	5.26 V	5.9 V	13.1 V
Q304	5.26 V	5.9 V	12.0 V
Q305	0	0.62 V	5.9 V
Q306	4.9 V	5.5 V	12.0 V
Q307	-12.0 V	-12.0 V	-18.6 V
Q308	-19.1 V	-18.6 V	-12.0 V
Q309	-5.3 V	-5.9 V	-12.6 V
Q310	-6.0 V	-6.5 V	-12.0 V
Q311	-6.0 V	-6.5 V	-8.8 V
* Cannot be measured			

Table 5.2 (a)

Transistor DC Voltages

PIN / Int. Cets.	1	2	3	4	5	6	7	8
QA101		0	0	-12.0 V		0.22 V	12.0 V	
QA102	-12.0 V	0	0	-12.0 V	-12.0 V	0	12.0 V	
QA103		0	0	-12.0 V		-4.0 V	12.0 V	
QA104	0	-10.0 V	-4.0 V	-5.9 V		0	-0.5 V	12.0 V
QA106		0	0	-12.0 V		0.1 V	12.0 V	
QA107	-12.0 V	0	0	-12.0 V	-12.0 V	-0.01 V		
QA108	-12.0 V	0	0	-12.0 V	-12.0 V	-0.06 V		
QA201		0	0	-12.0 V		0	12.0 V	
QA202		0	0	-12.0 V		0	12.0 V	
QA203		0	0	-12.0 V		0	12.0 V	
QA204		0	0	-12.0 V		0	12.0 V	
QA205		0	0	-12.0 V		0	12.0 V	

PIN	1	2	3	4	5	6	7	8
A105	0.09 V	-0.5 V	0.44 V	0	0.08 V	4.9 V	1.7 V	1.9 V

Table 5.2 (b)

Integrated Circuits DC Voltages

5.4 ALIGNMENT PROCEDURES

Test equipment required :

DC voltmeter
AC voltmeter } e.g. TF 2671, TF 2650

Low distortion oscillator e.g. TF 2100/1M1

5.4.1 Power Supply

(a) Test equipment :- DC voltmeter

(b) Remove the upper cover.
Connect a d.c. voltmeter between board A3 pin 7 and A3 pin 6.

(c) Adjust A3 R326 for a voltage of -12 ±0.5 V.

(d) Transfer the voltmeter leads to A3 pin 5 and 7.
Ensure that the voltage is +12 ±0.5 V.

(e) Measure the voltage between A3 pin 4 and 7. This should be +5 ±0.3 V.

5.4.2 Level Zero Adjustment

(a) Remove the lower cover. Set the FUNCTION switch to LEVEL and LEVEL RANGE 1 V.

(b) With no signal applied to the input adjust A1 R134 so that the LEVEL METER indicates zero.

5.4.3 Level Gain

(a) Test equipment :- Low distortion oscillator.

(b) Set the FUNCTION switch to LEVEL and LEVEL RANGE to 1 V.
Apply a signal of 1 kHz, 1 V r.m.s. to the input terminal.

(c) Adjust A1 R119 so that the LEVEL METER indicates full scale.

5.4.4 Distortion Zero Adjustment

(a) Test equipment :- Low distortion oscillator.

(b) Set the FUNCTION switch to LEVEL, the LEVEL RANGE to 1 V and the DISTORTION RANGE to a convenient point.

(c) Apply a signal of 1 kHz 1 V r.m.s. to the TF 2337A input terminals. Adjust A1 R184 so that the distortion meter reads zero.

5.4.5 Distortion Gain and Ratio Adjustment

(a) Test equipment :- Low distortion oscillator.

(b) Set the FUNCTION switch to CAL., LEVEL RANGE to 1 V.

(c) Apply a signal of 1 kHz 1 V r.m.s. to the input terminals.
Adjust R159 so that the distortion meter indicates full scale.

(d) Set the TF 2337A LEVEL RANGE switch to 3 V. Adjust A1 R176 so that the distortion meter again indicates full scale.

(e) Repeat items (b) to (d) as necessary so that the distortion meter indicates full scale.

5.4.6 400 Hz Band Rejection Filter

(a) Test equipment :- Low distortion oscillator.

(b) Press the CAL and 400 Hz filter switches simultaneously.

(c) Apply a signal of 2 kHz 1 V r.m.s. to the input terminals of the TF 2337A. Adjust A2 R202 (400 Hz)., for full scale deflection of the distortion meter.

(d) Change the input frequency to 800 Hz. Adjust A2 R227 (400 Hz filter) for full scale deflection of the distortion meter.

(e) Repeat operations (b) to (d) as necessary so that the distortion meter indicates f. s. d.

5.4.7 1000 Hz Band Rejection Filter

(a) Test equipment :- Low distortion oscillator.

(b) Press the CAL and 1000 Hz filter switches simultaneously.

(c) Apply a signal of 5 kHz 1 V r. m. s. to the TF 2337A input terminals. Adjust A2 R202 (1000 Hz) for distortion meter f. s. d.

(d) Change the input frequency to 2 kHz, adjust A2 R227 (1000 Hz) so that the distortion meter indicates f. s. d.

(e) Repeat operations (b) to (e) as necessary so that the distortion meter indicates f. s. d.

5.4.8 Bias Adjustment

(a) Test equipment :- Low distortion oscillator.

(b) Set the FUNCTION switch to 400 Hz. LEVEL RANGE to 1 V and DISTORTION RANGE to 0.1%. Apply a signal of 400 Hz, 1 V r. m. s. to the TF 2337A input terminals.

(c) Adjust A1 R105 so that the distortion meter indicates less than 0.007%.

(d) Set the FUNCTION switch to 1000 Hz. Alter the input frequency to 1000 Hz. Ensure that the distortion meter indicates less than 0.007%.

5.5 CHASSIS WIRING CHECK

Fig. 5.2 shows the chassis connector layout.

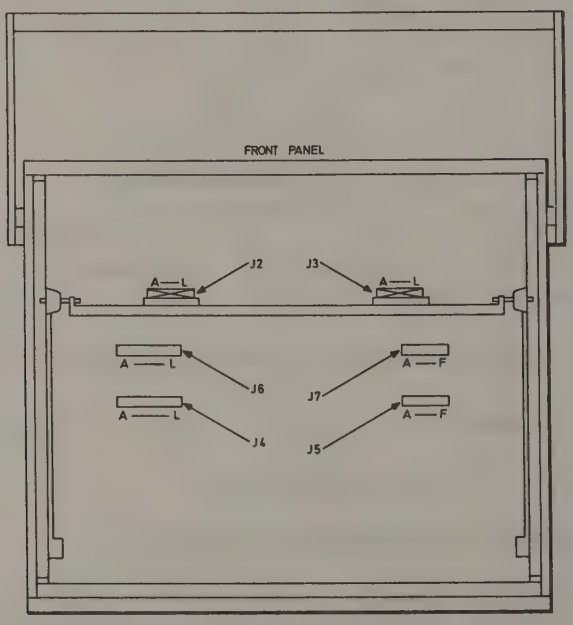


Fig. 5.2 Chassis Connector Layout Diagram

Connector No.	Pin No.	Front Panel Setting	Resistance
J2	A, L		0
	B	Level range : 0.3 V : 1 V : 3 V : 10 V : 30 V : 100 V	100 kΩ 31.6 kΩ 10 kΩ 3.16 kΩ 1 kΩ 316 Ω
	D		2.7 Ω
	H	Function : Level : 400 Hz, 1000 Hz : CAL	1.2 kΩ ∞ 600 Ω
	J		2.7 kΩ
J3	A, L		0
	B		500 Ω
	E		2.7 kΩ
	F		2.7 kΩ
	J		10 kΩ
	K	(FUNCTION : LEVEL) Distortion range : 0.1 : 0.3 : 1 : 3 : 10% : 30%	 0 130 Ω 143 Ω 144 Ω 144 Ω 144 Ω
		(FUNCTION : 400 Hz & 1000 Hz) Distortion range : 0.1% Distortion : 0.3% : 1% : 3% : 10% : 30%	 600 Ω 180.7 Ω 148.7 Ω 144.0 Ω 144.2 Ω 144.2 Ω
		(FUNCTION : CAL) Distortion range : 0.1% 30%	 144.6 Ω

Connector No.	Pin No.	Front Panel Setting	Resistance
J4	A, I		0
	B		∞
	E, H		2.7 kΩ
J5	E	FUNCTION : Level : 400 Hz : 1000 Hz : CAL	∞ 600 Ω ∞ ∞
	F		0
J6	A, L		0
	B		∞
	C		1.2 kΩ
	E, H		2.7 kΩ
J7	E	FUNCTION : Level : 400 Hz : 1000 H : CAL	∞ ∞ 600 Ω ∞
	F		0

Table 5. 3 Connector Resistance Checks

Table 5.3 indicates the resistance between connector pins and chassis. When making resistance checks disconnect the instrument from the mains supply and remove boards A1 and A2 (both 400 and 1000 Hz).

5.6 PACKAGING FOR RESHIPMENT

In the event of the equipment being returned for servicing it should be packed in the original shipping carton and packing material. If this is not available wrap the instrument in heavy paper or plastic and place in a rigid outer box of wood, fibreboard or very strong corrugated cardboard. Use ample soft packing to prevent movement. Provide additional support for projecting parts to relieve these of unnecessary shock. Close the carton securely and seal with durable tape. Mark the shipping container FRAGILE to ensure careful handling.

Chapter 6

Replaceable parts

6.1 INTRODUCTION

This section lists replaceable parts in alphabetical - numerical order of their circuit references.

The following abbreviations and symbols are used :-

C	:	capacitor
CARB	:	carbon
D	:	semi conductor diode
ELECT	:	electrolytic
FS	:	fuse
J	:	connectors
LP	:	indicator lamp
M	:	meter
MET	:	metal
QA	:	integrated circuits
Q	:	transistor
R	:	resistor
S	:	switch
T	:	transformer
W	:	watt

6.2 ORDERING

When ordering replacements or spare parts, address the order to :

Marconi Instruments Service Division,
The Airport,
Luton,
Bedfordshire.

or to your nearest representative. Please specify the following information for each part required :

1) Type of instrument
2) Circuit reference (e.g. C1)
3) Description (e.g. 1 μF 250 V Paper Capacitor)
4) M.I. Part Number (e.g. TF 2337A/FPP 26001)

If a part is not listed, state its function, location and description when ordering.

Spares supplied against M.I. Part Numbers are electrically inter-changeable with those originally fitted, but may not always be identical.

6.3 PARTS LIST

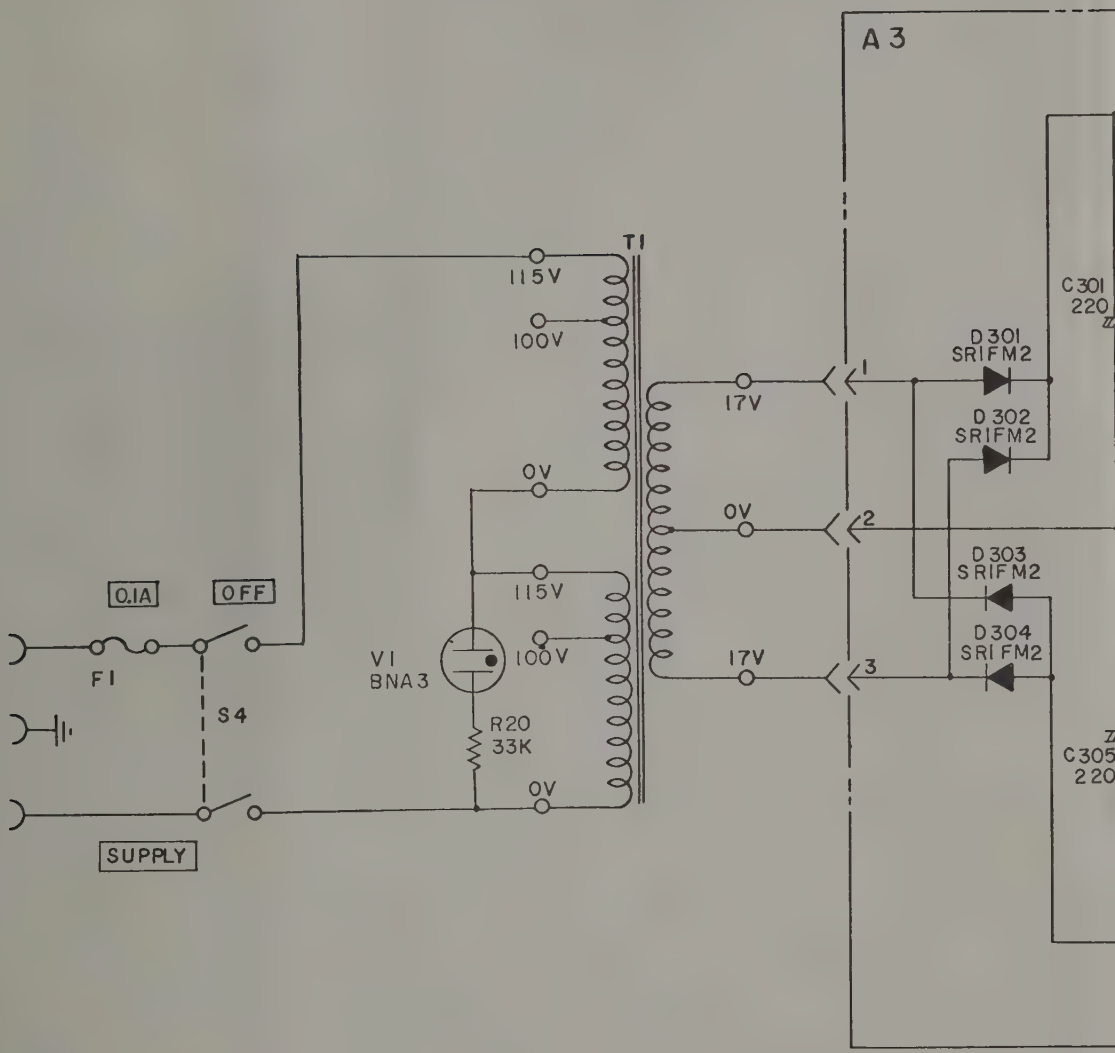
Circuit reference	Description		M.I. Code No. FPP/2337A
Capacitors			
C1	1μF ±20% 250V	Paper	26001
C2	47pF ±10% 100V	Mica	26002
C3	150pF ±10% 100V	Mica	26003
C4,111	470pF ±10% 100V	Mica	26004
C101	22pF ±10% 100V	Mica	26005
C102,103	0.01μF ±20% 100V	Plastic	26009
C104	0.047μF ±20% 100V	Plastic	26010
C105,109, 120	47μF +100% -10% 10V	Elect	26017
C106,121	100μF +100% -10% 10V	Elect	26018
C107,116	33μF +100% -10% 10V	Elect	26019
C108,119 123	1000pF ±10% 100V	Mica	26006
C110,122	47μF +75%-15% 16V	Elect	26020
C112,124	4.7μF +100%-10% 25V	Elect	26021
C113	0.15μF ±5% 150V	Elect	26011
C114	330pF ±10% 100V	Mica	26007
C115	100pF ±10% 100V	Mica	26008
C117,118	0.33μF ±5% 200V	Plastic	26012
C125	10μF +100%-10% 16V	Elect	26022
C126,127	47μF +100%-10% 16V	Elect	26023
C201,202 204,205 207,208 210,211	0.025μF ±1% 50V (400 Hz Band Stop Filter)	Plastic	26013
C201,202 204,205 207,208 210,211	0.01μF ±1% 50V (1000 Hz Band Stop Filter)	Plastic	26015
C203,206 209,212	0.05μF ±1% 50V (400 Hz Band Stop Filter)	Plastic	26014
C203,206 209,212	0.02μF ±1% 50V (1000 Hz Band Stop Filter)	Plastic	26016
C301,305	220μF +100% -10% 25V	Elect	26024
C302,306	22μF +100%-10% 25V	Elect	26025
C303,307	0.01μF +80%-20% 25V	Ceramic	26026
C304,308	47μF +100%-10% 16V	Elect	26023
Diodes			
D101,102 112,306	02Z 6.2A	Zener 6.2V	28101
D102-111, 113,114, 116,117	1S 2076	Silicon	28102
D115	1S 2190	Zener 8.3V	28103
D301-304	SR1FM2	Silicon rectifier	28104
D305	1S 2076	Silicon	28102
Fuses			
FS1	0.2 Amp cartridge		23401

Circuit reference	Description		M.I. Code No. FPP/2337A
Connectors			
J1	Input terminal		23003
	Earth terminal		23004
J2-4,6	PCB jack (10 contacts)		23001
J5,7	PCB jack (6 contacts)		23002
Lamps			
LP1	Lamp Neon BNA-3		23701
Meters			
M1	500μA DC (Level)		44501
M2	500μA DC (Distortion)		44502
Transistors			
Q101	2SK30A FET N Channel		28201
Q102,105 112	2SA495G-Y	PNP	28202
Q103,104 107,110 111,114	2SC1000G-BL	NPN	28203
Q106,113	2SC373G	NPN	28204
Q108,109	2SC752G-O	NPN	28205
Q301, 303-306	2SC372G-Y	NPN	28206
Q302,308	2SD91	NPN	28207
Q307, 309-311	2SA495G-Y	PNP	28202
Integrated Circuits			
QA101-103 106-108	SN72741 L		28401
QA104	SN72710 L		28402
QA105	M5946 P		28403
QA201-205	SN72741 L		28401
Resistors			
R1	68.4kΩ ±0.5% ¼W	Met film	24001
R2	21.6kΩ ±0.5% ¼W	Met film	24002
R3	6.84kΩ ±0.5% ¼W	Met film	24003
R4	2.16kΩ ±0.5% ¼W	Met film	24004
R5	648Ω ±0.5% ¼W	Met film	24005
R6	316Ω ±0.5% ¼W	Met film	24006
R7	1.2kΩ ±5% ¼W	Carb film	24013
R8,10,12 14,16,18	410.3Ω ±0.5% ¼W	Met film	24007
R9,11,13 15,17	277.5Ω ±0.5% ¼W	Met film	24008
R19	189.7Ω ±0.5% ¼W	Met film	24051
R20	33kΩ ±5% ¼W	Carb film	24014
R101,112,113 117	10kΩ ±5% ¼W	Carb film	24015
R102/103, 111	2.7kΩ ±5% ¼W	Carb film	24016
R104	68kΩ ±5% ¼W	Carb film	24017

Circuit reference	Description		M.I. Code No. FPP/2337A
R105,119,134	10kΩ	Variable Wire Wound	25001
R106	18kΩ ±5% ¼W	Carb film	24018
R107	1MΩ ±5% ¼W	Carb film	24019
R108,143	6.8kΩ ±5% ¼W	Carb film	24020
R109,165,177	680Ω ±5% ¼W	Carb film	24021
R110,118	3.3kΩ ±5% ¼W	Carb film	24022
R114,127	1kΩ ±5% ¼W	Carb film	24023
R115,116,125	100Ω ±5% ¼W	Carb film	24028
R120,128,129,131	2.2kΩ ±5% ¼W	Carb film	24024
R121,161	270Ω ±5% ¼W	Carb film	24025
R122,174	5.6kΩ ±5% ¼W	Carb film	24026
R123	12kΩ ±5% ¼W	Carb film	24027
R124	1.2kΩ ±5% ¼W	Carb film	24013
R126,136	22kΩ ±5% ¼W	Carb film	24032
R130	4.3kΩ ±5% ¼W	Carb film	24029
R132,164	1.5kΩ ±5% ¼W	Carb film	24030
R133	15kΩ ±5% ¼W	Carb film	24031
R135,140,142, 145,152,153	10kΩ ±5% ¼W	Carb film	24015
R137,138	3.3kΩ ±1% ¼W	Carb film	24043
R139,144,146, 148,151	4.7kΩ ±5% ¼W	Carb film	24033
R141	6.8kΩ ±1% ¼W	Carb film	24044
R147	27kΩ ±5% ¼W	Carb film	24034
R149,150	39kΩ ±1% ¼W	Carb film	24045
R154	820Ω ±5% ¼W	Carb film	24035
R155,156, 167	100Ω ±5% ¼W	Carb film	24028
R157,166	10kΩ ±5% ¼W	Carb film	24015
R158	47Ω ±5% ¼W	Carb film	24036
R159,176,184	10kΩ	Variable Wire Wound	25001
R160,169,189	2.2kΩ ±5% ¼W	Carb film	24024
R162	3.3kΩ ±5% ¼W	Carb film	24022
R163	20kΩ ±5% ¼W	Carb film	24037
R168	1kΩ ±5% ¼W	Carb film	24023
R170,171	2kΩ ±5% ¼W	Carb film	24038
R172,173,178	4.7kΩ ±5% ¼W	Carb film	24033
R175,179	10kΩ ±5% ¼W	Carb film	24015
R180,181	3.3kΩ ±1% ¼W	Carb film	24043
R182	2.7kΩ ±5% ¼W	Carb film	24016
R183,185	10kΩ ±1% ¼W	Carb film	24042
R186	1MΩ ±5% ¼W	Carb film	24019
R187,188	100kΩ ±5% ¼W	Carb film	24053
R201	1.2kΩ ±5% ¼W	Carb film	24013
R202	200Ω	Variable Wire Wound	25002
R203	2kΩ ±5% ¼W	Carb film	24038
R204,228	1kΩ ±5% ¼W	Carb film	24023
R205,206,211,212, 217,218,223,224	15.9kΩ ±0.5% ¼W	Met film	24011
R207,213	7.95kΩ ±0.5% ¼W	Met film	24012
R208,214,220,226	33kΩ ±5% ¼W	Carb film	24014
R209	240Ω ±1% ¼W	Carb film	24046
R210,216,222	1kΩ ±1% ¼W	Carb film	24047
R215	33Ω ±1% ¼W	Carb film	24048

Circuit reference	Description		MI. Code No. FPP/2337A
R219,225	7.95kΩ ±0.5% ¼W	Met film	24052
R221	270Ω ±1% ¼W	Carb film	24049
R227	100Ω	Variable Wire Wound	25003
R301,314	10Ω ±5% ¼W	Carb film	24039
R302,311,315, 323,325	2.2kΩ ±5% ¼W	Carb film	24024
R303,308,316, 321,324	4.7kΩ ±5% ¼W	Carb film	24033
R304,317	100Ω ±5% ¼W	Carb film	24028
R305,306,313, 318,319,322	10kΩ ±5% ¼W	Carb film	24015
R307,320	1.8kΩ ±5% ¼W	Carb film	24040
R309	39kΩ ±5% ¼W	Carb film	24041
R310,328	4.7kΩ ±1% ¼W	Carb film	24050
R312	2kΩ ±5% ¼W	Carb film	24038
R326	500Ω	Variable Wire Wound	25004
R327	2.7kΩ ±5% ¼W	Carb film	24016

Switches		
S1	Switch (LEVEL RANGE) 6 button	23105
S2	Switch (FUNCTION) 4 button	23102
S3	Switch (DISTORTION RANGE) 6 button	23106
S4	Switch (POWER) toggle	23104


A 3
T1
115V
100V
0V
115V
100V
0V
17V
0V
17V
1
2
3
D 301
SRIFM2
D 302
SRIFM2
D 303
SRIFM2
D 304
SRIFM2
C301
220
0.1A
OFF
F1
S4
V1
BNA3
R20
33K
SUPPLY

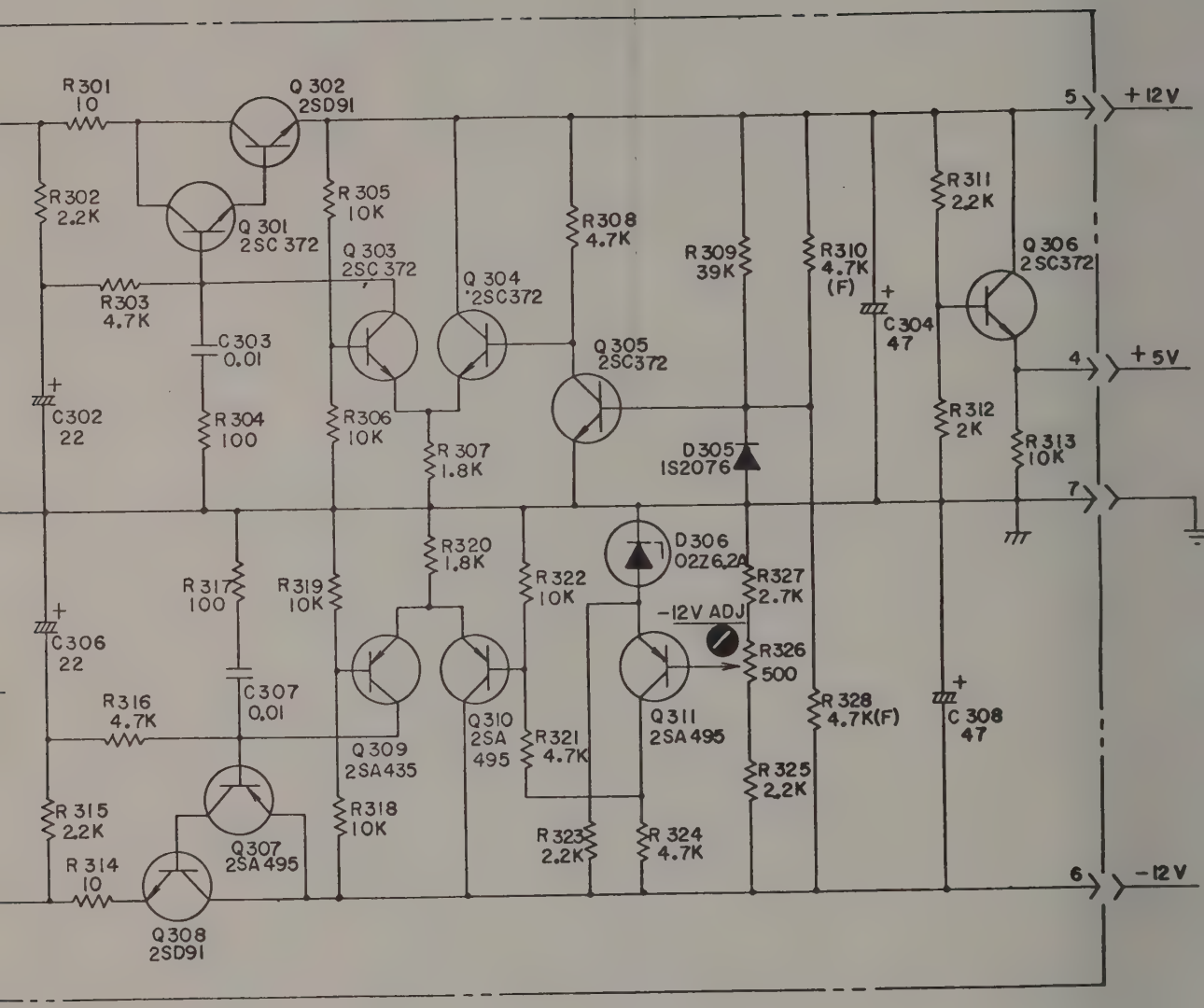
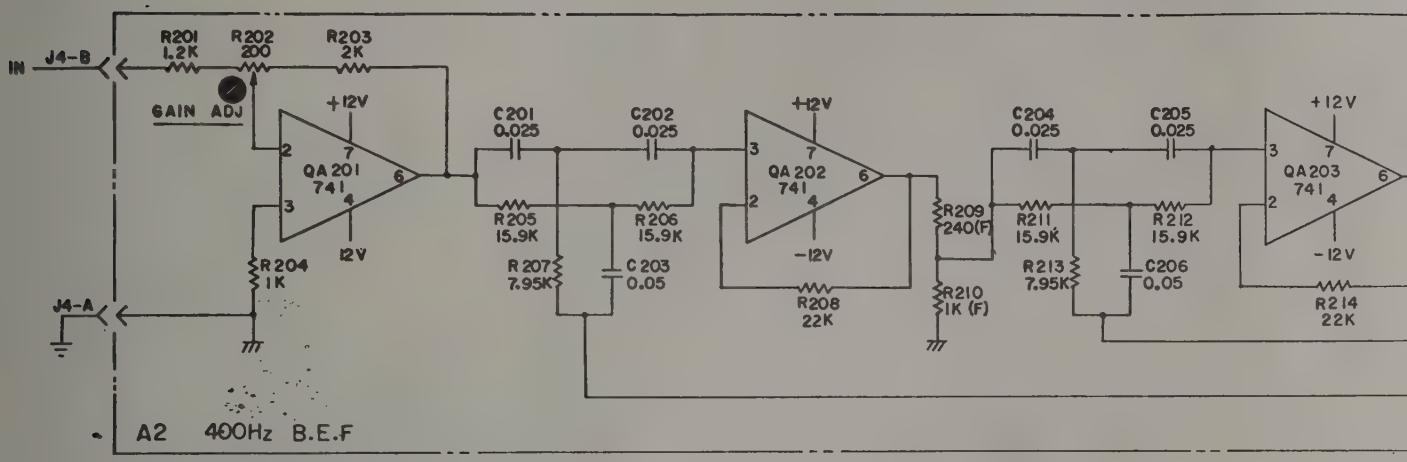
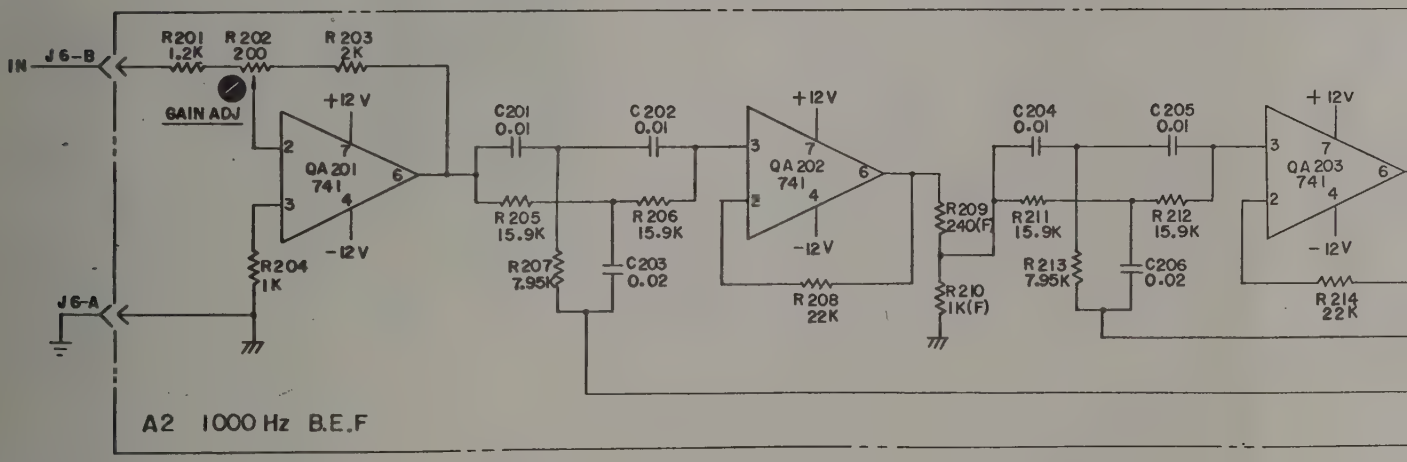


Fig.7.1 Power Supply Circuit Diagram


IN
J4-B
R201
1.2K
R202
200
R203
2K
GAIN ADJ
+12V
QA 201
741
-12V
R204
1K
J4-A
C201
0.025
C202
0.025
R205
15.9K
R206
15.9K
R207
7.95K
C203
0.05
QA 202
741
R208
22K
R209
240(F)
R210
1K (F)
C204
0.025
C205
0.025
R211
15.9K
R212
15.9K
R213
7.95K
C206
0.05
QA 203
741
R214
22K
A2 400Hz B.E.F


IN
J6-B
R201
1.2K
R202
200
R203
2K
GAIN ADJ
+12V
QA 201
741
-12V
R204
1K
J6-A
C201
0.01
C202
0.01
R205
15.9K
R206
15.9K
R207
7.95K
C203
0.02
QA 202
741
R208
22K
R209
240(F)
R210
1K(F)
C204
0.01
C205
0.01
R211
15.9K
R212
15.9K
R213
7.95K
C206
0.02
QA 203
741
R214
22K
A2 1000 Hz B.E.F

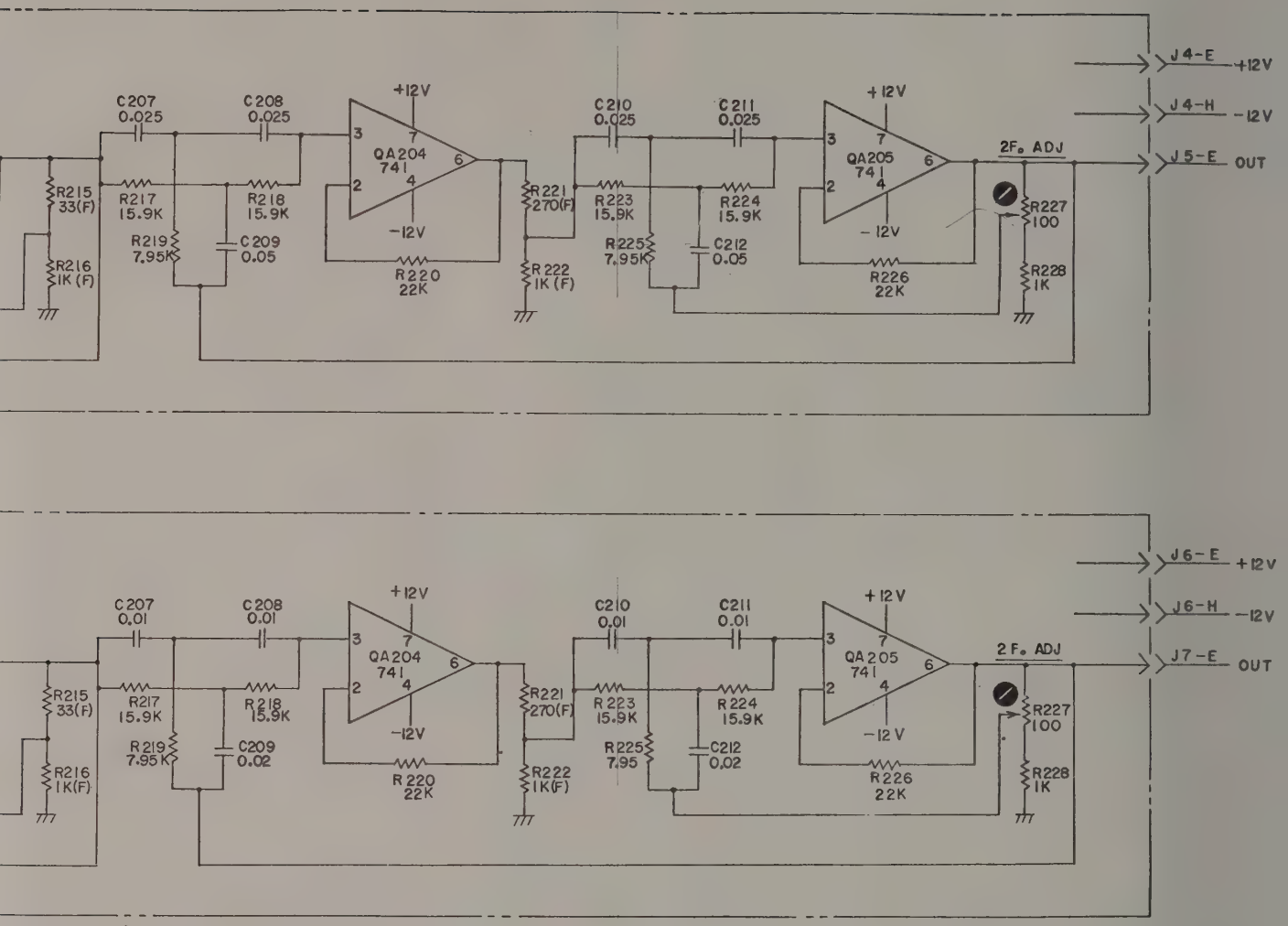
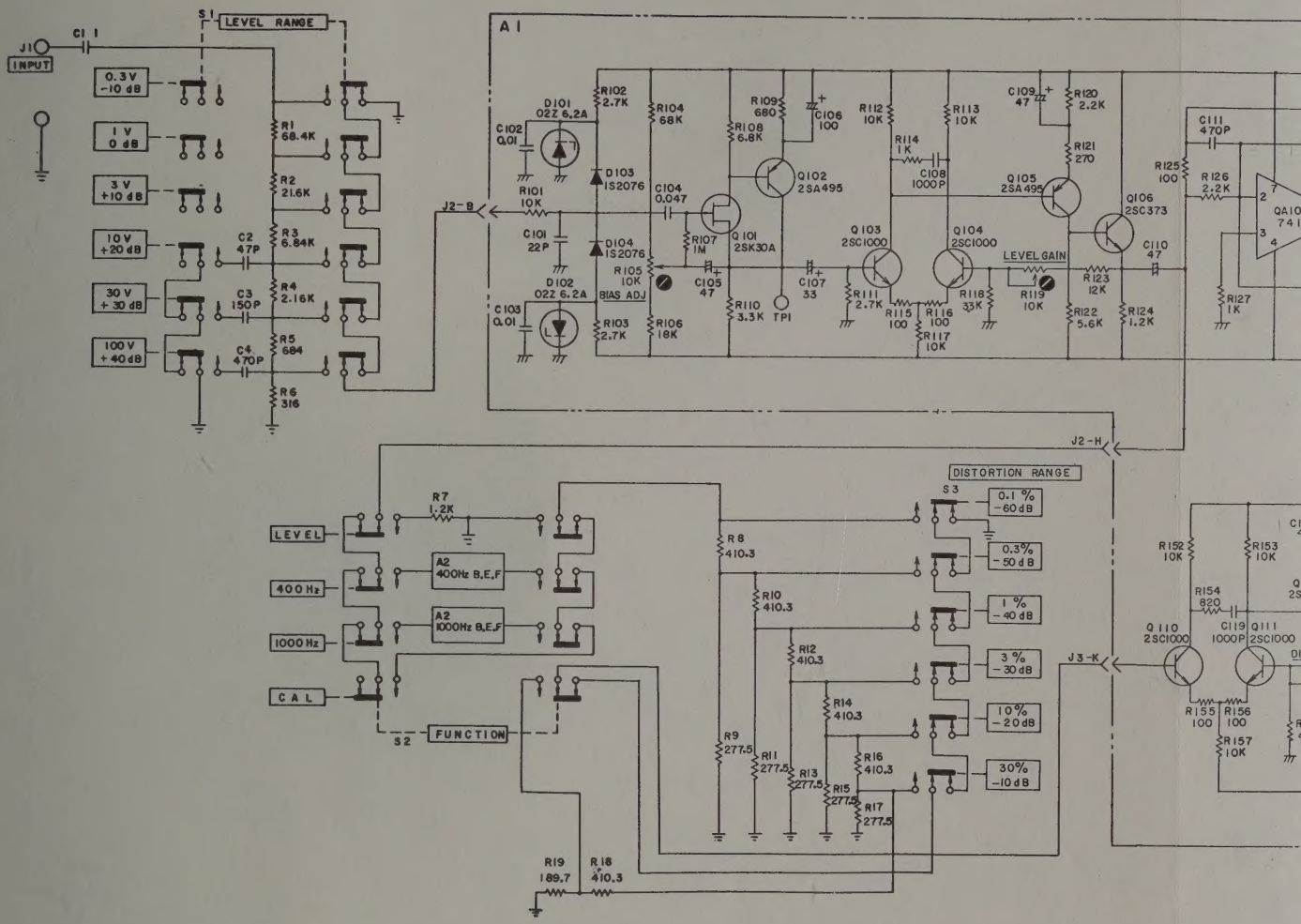


Fig.7.2 Band-Stop Filter Circuit Diagram


J1
INPUT
C1 1
S1
LEVEL RANGE
0.3 V -10 dB
1 V 0 dB
3 V +10 dB
10 V +20 dB
30 V +30 dB
100 V +40 dB
R1 68.4K
R2 21.6K
R3 6.84K
R4 2.16K
R5 684
R6 316
C2 47P
C3 150P
C4 470P
A1
J2-B
D101 02Z 6.2A
D102 02Z 6.2A
D103 1S2076
D104 1S2076
C102 0.01
C103 0.01
C101 22P
R101 10K
R102 2.7K
R103 2.7K
R104 68K
R105 10K
BIAS ADJ
R106 18K
C104 0.047
C105 47
R107 1M
Q101 2SK30A
R108 6.8K
R109 680
C106 100
Q102 2SA495
R110 3.3K
TP1
C107 33
R111 2.7K
Q103 2SC1000
R112 10K
R113 10K
R114 1K
C108 1000P
R115 100
R116 100
R117 10K
Q104 2SC1000
R118 33K
LEVEL GAIN
R119 10K
C109 47
Q105 2SA495
R120 2.2K
R121 270
R122 5.6K
Q106 2SC373
R123 12K
R124 1.2K
C110 47
C111 470P
R125 100
R126 2.2K
R127 1K
J2-H
J3-K
DISTORTION RANGE
S3
0.1 % -60 dB
0.3% -50 dB
1 % -40 dB
3 % -30 dB
10 % -20 dB
30% -10 dB
R7 1.2K
R8 410.3
R10 410.3
R12 410.3
R14 410.3
R16 410.3
R9 277.5
R11 277.5
R13 277.5
R15 277.5
R17 277.5
R19 189.7
R18 410.3
LEVEL
400 Hz
1000 Hz
CAL
A2 400Hz B,E,F
A2 1000Hz B,E,F
S2
FUNCTION
R152 10K
R153 10K
R154 820
C119 1000P
Q110 2SC1000
Q111 2SC1000
R155 100
R156 100
R157 10K

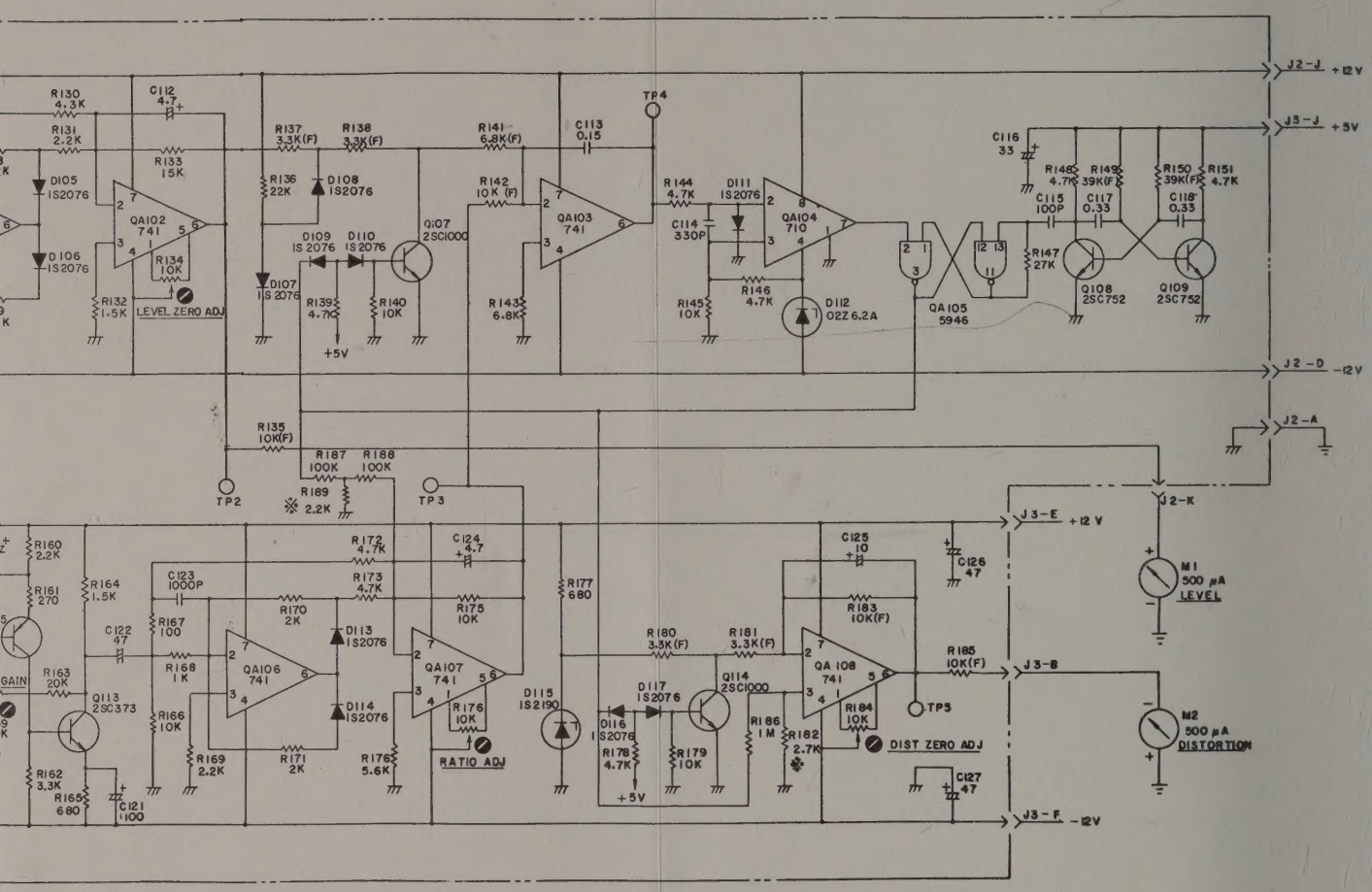


Fig.7.3 Metering Circuit Diagram

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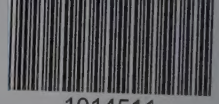

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